Stratospheric Aerosol and Gas Experiment (SAGE) III

Validation Summary

October 15, 2001

Introduction

SAGE III is a 4th generation satellite-borne instrument and a crucial element in the NASA's Earth Observing System (EOS). Its mission is to increase our understanding of natural and human-derived atmospheric processes by providing accurate long-term measurements of the vertical structure in the upper troposphere and stratosphere of aerosols, O_3, H_2O, $NO_{2,}$, temperature/pressure, NO_3, and OClO.

Like its predecessor instruments (SAM II, SAGE I, and SAGE II), SAGE III utilizes the occultation measurement technique. This technique is inherently self-calibrating and allows for reliable long-term trend analysis.

Two SAGE III instruments will be placed in orbit. The first instrument will be flown upon the Russian Meteor-3M spacecraft as a joint effort between NASA and the Russian Space Agency, which is scheduled for launch in **December 2001**. The second instrument will be placed upon the International Space Station in **2005.**

A description of the SAGE III mission is available at (http://www-sage3.larc.nasa.gov/sage3/).

SAGE III Science Objectives

Provide near-global profiles of aerosols, O_3, H_2O, NO_2, temperature and pressure, NO_3, and OClO.

Investigate the spatial and temporal variability of the measured species in order to determine their role in atmospheric chemistry, climatological processes, biogeochemical cycles, and the hydrologic cycle.

Characterize tropospheric as well as stratospheric aerosols and upper tropospheric and stratospheric clouds, and investigate their effects on the Earth's environment including radiative, microphysical, and chemical interactions.

Extend the SAM II, SAGE I, and SAGE II data sets, enabling the detection of long-term trends.

Provide atmospheric data essential for the calibration and interpretation or correction of other satellite sensors, including EOS and ground-based networks.

SAGE III Instrument

- The SAGE III instrument incorporates two new elements: a CCD linear array of detectors and a 16-bit A/D converter.

- Spectral coverage between 280 and 1550 nm, with continuous coverage between 280 and 1030 nm at ~1 nm resolution by the CCD. Measurements at 1550 nm by a discrete photodiode.
  - 12 solar channels (~80 sub-channels) routinely utilized during solar occultation measurements
  - 3 lunar channels (~340 sub-channels) utilized during lunar occultation measurements

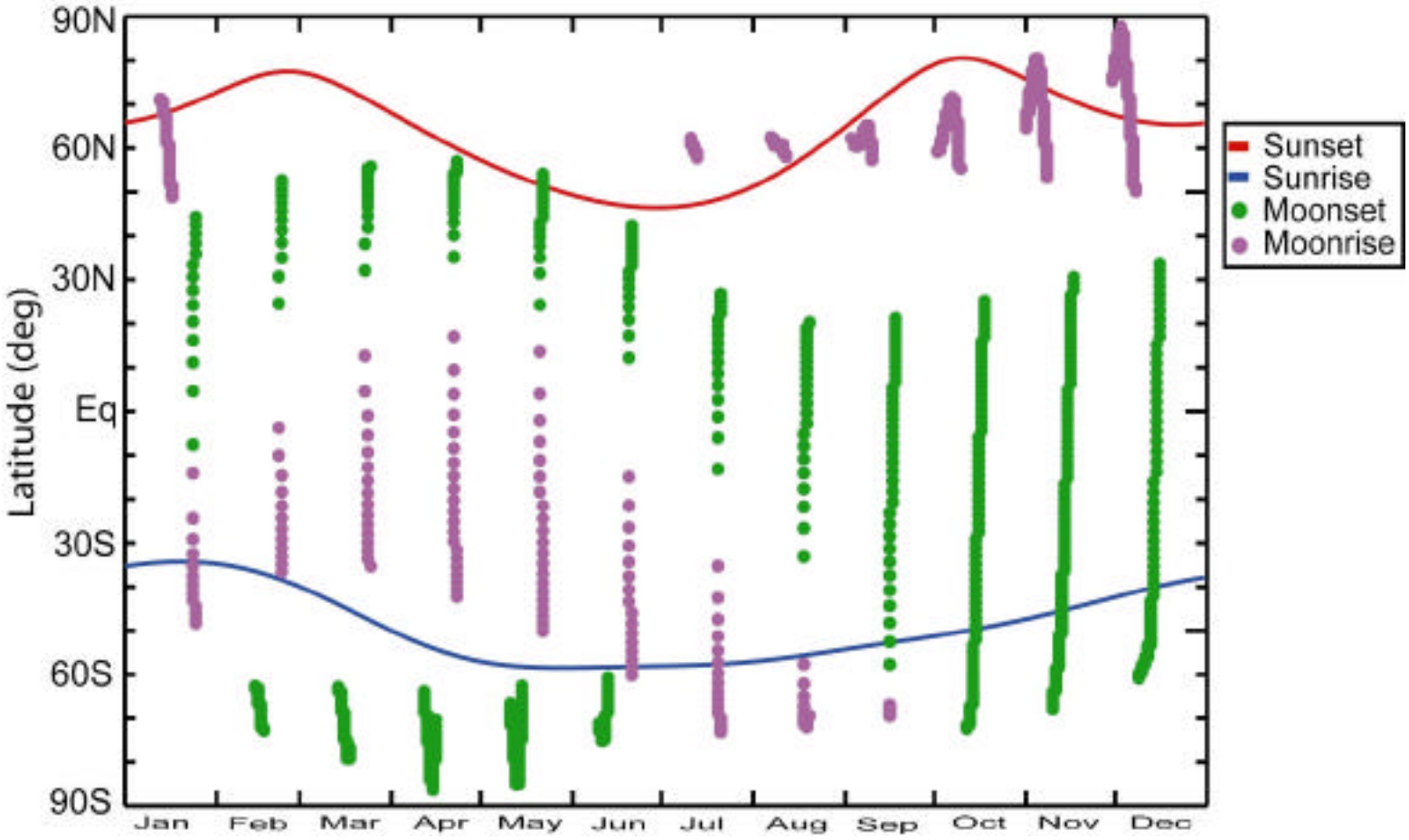
- CCD linear detector array permits on-orbit wavelength and intensity calibration from exoatmospheric solar Fraunhofer spectrum.

SAGE III instrument prior to integration on the Meteor 3M spacecraft

SAGE III Data Products

Product Name	Accuracy/Precision	Vertical Resolution/Range
Transmission profiles	0.05%:0.05%	0.5 km:0-100 km
Aerosol extinction profiles and stratospheric optical depth at 8 wavelengths (385, 449, 521, 676, 756, 869, 1019, & 1538 nm)	5%:5%	0.5 km:0-40 km
H_2O Concentration (altitude)	10%:15%	0.5 km: 0-50 km
NO_2 Concentration (altitude) Slant path column amt.	10%:15%	0.5 km: 10-50 km 0.5 km: 10-50 km
NO_3 (lunar only) Concentration (altitude)	10%:10%	0.5 km: 20-55 km
O_3 Concentration (Altitude) Slant path column amt.	6%:5%	0.5 km: 6-85 km 0.5 km: 50-85 km
OClO (lunar only) Concentration (altitude)	25%:20%	0.5 km: 15-25 km
Pressure	2%:2%	0.5 km: 0-85 km
Temperature	2 K:2 K	0.5 km: 0-85 km
Cloud presence	N/A	0.5 km: 6-30 km

Meteor 3M/SAGE III Coverage



Nominal annual SAGE III measurement coverage
for 2003

Validation Overview

- Analysis of SAGE III instrument and engineering data to ascertain its health and performance characteristics.

- Perform self-consistency analysis to evaluate instrument performance and soundness of the algorithm retrieval process.

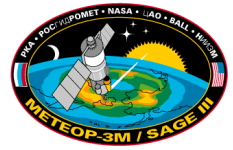
- Inter-compare SAGE III standard science data products with external correlative measurements collected under varying atmospheric conditions and over large altitude regimes to assess relative accuracies and precision.

- Examine SAGE III data products with results from a forward retrieval algorithm to gain better understanding of some of the underlying assumptions in the retrieval algorithm.

Correlative Measurement Objectives

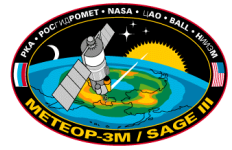
- Obtain correlative profile measurements of SAGE III solar and lunar science products to examine relative accuracy and precision.
- Maximize time/space coincidence of correlative measurements with aircraft and balloon flights to reduce uncertainties due to the sampling of different air masses.
- Improve statistical significance of measurement inter-comparisons through larger aircraft instrument sampling rates and trajectory analysis techniques.
- Obtain measurements along satellite-sun/moon line-of-sight.
  - to assess the inhomogeneityof species and their impact on retrieved products (constituent gradients, cirrus, polar stratospheric clouds, & diurnally varying species)
  - below 20 km where discrepancieswith other satellite measurementsare more pronounce and a critical region for ozone/water vapor trends
  - to determine altitude registrationof transmissionprofile (<100 m) through the identification of cloud or constituent gradient structures
- Acquire measurements under varying atmospheric conditions.

Correlative Measurement Activities



- Satellite Comparisons
  - SAGE II, POAM III, SBUV, GOME, ENVISAT (2002), ADEOS II (2002), ACE (2002), AURA (2004), and others
- Routine correlative measurements with key ground-based instrument facilities on a measurement-of-opportunity basis
  - Network for the Detection of Stratospheric Change (NDSC) sites
  - Measurement of Ozone and Water Vapor by Airbus In-Service Aircraft (MOZAIC)
  - WMO ozonesonde network sites
  - Russian measurement sites
- Correlative measurement activities
  - SOLVE-2 (January-February 2003)
  - Leverage upon European ENVISAT and Japanese ADEOS-II validation activities
  - EOS AURA validation program (ISS/SAGE III validation)

SOLVE-2 Overview



- The second **S**AGE III **O**zone **L**oss and **V**alidation **E**xperiment (SOLVE-2) is a DC-8 aircraft and small balloon measurement campaign that will focus on acquiring correlative data needed to validate measurements from the Meteor-3M/SAGE III satellite mission.

- SOLVE-2 is an extension of the original SOLVE campaign conducted in the Arctic during the 1999-2000 winter in which direct SAGE III intercomparison activities were not accomplished because of a prolonged delay in the launch of the satellite instrument.

- The mission will take place between January and February 2003 with aircraft measurements based from a high and mid latitude site. Balloon measurements probably will be based at Esrange, Sweden.

- SOLVE-2 is co-sponsored by the Upper Atmosphere Research Program (UARP), the Atmospheric Chemistry Modeling and Analysis Program (ACMAP), and the Earth Observing System (EOS) of NASA's Earth Science Enterprise (ESE).

- A NASA Research Announcement for SOLVE-2 is expected in the Fall of 2001.

Leverage with Existing Ground-based Networks

NETWORK	ANCHOR SITES	CORRELATIVE MEASUREMENT
Network for the Detection of Stratospheric Change (NDSC)	Ny Alesund, Norway Kiruna, Sweden Table Mountain, US Mauna Loa, US Lauder, New Zealand	aerosol, O_3, H_2O, and NO_2 profiles; aerosol, O_3, NO_2, NO_3, and OClO column abundances
WMO ozonesondes and radiosondes	multiple locations world wide	ozone and temperature profiles
Russian measurement	Murmansk, Tomsk, Moscow, north Caucasus sites	aerosol, O_3, & NO_2 profiles; NO_2 column abundances
International aerosol lidar	multiple locations world wide	aerosol profiles

Supporting Activities

- SAGE III website (http://www-sage3.larc.nasa.gov)
  - Quick access of data to SAGE III science team
  - Public access of data via the LaRC Atmospheric Science Data Center (http://eosweb.larc.nasa.gov)
  - Advertise predicted SAGE III measurement locations

- Science Team members on data comparison or validation teams for:
  - Network for the Detection of Stratospheric Change
  - World Meteorological Organization's Ozonesonde Network
  - ENVISAT, ADEOS II, ACE, and AURA satellite missions
  - SPARC trend analysis

- Interact with NASA's R&A programs to identify future correlative measurement activities and to enhance scientific value of SAGE III program